HYDROLOGIC CONDITION ANALYSIS

Keith R. McLaughlin

AUTHOR: Regional Hydrologist, USDA Forest Service, Southern Region, Atlanta, Georgia 30367
REFERENCE: Proceedings of the 1997 Georgia Water Resources Conference, held March 20-22, 1997, at The University of Georgia, Kathryn J. Hatcher, Editor, Institute of Ecology, The University of Georgia, Athens, Georgia.

Abstract. The Forest Service (FS) and Bureau of Land Management (BLM) have developed standard protocols for delineating watersheds, analyzing hydrologic condition for watersheds and preparing a watershed case file. These protocols provide a national approach for determining hydrologic condition of watersheds administered by BLM and FS. The results are used (1) in preparing Forest Service land management plans, and (2) to provide part of the rationale for listing or delisting waters that have impaired water quality per Section 303(d) of the Clean Water Act and to prioritize watersheds for treatment.

INTRODUCTION

The Forest Service (FS) and Bureau of Land Management (BLM) have the responsibility for managing natural resources on public lands. To meet this responsibility, it is necessary to understand physical processes that govern flow, quality , and/or timing of water. Understanding these processes requires information on precipitation, groundcover, vegetation, soils, geology, runoff, channels, floodplains, and riparian areas. As a contribution to the interdisciplinary process, an analyst needs to interpret this information using known scientific principles about hydrologic and hydro-meteorological processes to describe the hydrologic condition of a watershed. This basic information enables the analyst to participate effectively with other interdisciplinary team members in addressing ecosystem and resource management issues.

In November, 1994, the Chief of the Forest Service and Director of the Bureau of Land Management chartered a team to develop "National Approaches for Determining Hydrologic Condition of Watersheds Administered by the Bureau of Land Management and Forest Service." A core team of BLM and FS personnel was established to develop protocols for : (1.) watershed delineation, (2.) core hydro-meteorological data and information, and (3.) hydrologic condition analysis. The core team was guided by a Steering Team. The members of the Steering Team are from BLM, FS, Natural Resources Conservation Service (NRCS), and the Environmental Protection Agency (EPA). These protocols have been developed and are currently being reviewed for submission for consideration as BLM/FS policy and direction.

The purpose for this paper is to briefly describe the six step protocol for hydrologic condition analysis and its relationship to the protocols for delineating watersheds and core hydro-meteorological data and information.

OVERVIEW OF HYDROLOGIC CONDITION ANALYSIS

Ecosystem and resource management planning and analyses include determinations of current and predicted economic, social, biological, and physical conditions, at variable scales. Four scales of ecosystem analysis are: regional, basin-wide, watershed (20-200 square miles, i.e. 5th and 6th level hydrologic units), and site. The protocol for hydrologic condition analysis is intended to be used to assess hydrologic condition of 5th or 6th level code hydrologic units during land and resource management planning efforts. The process is intended to provide the broad context and to point to specific data and information which are needed for subsequent project investigations, design, prescriptions, and implementation.

Hydrologic condition analysis results in an understanding of the interrelationships between meteorlogical, surface and ground water, physical and biological factors that influence water flow, quality, or timing (F, Q, and/or T). The magnitude, direction, and rate of change in flow, quality, or timing are the expression of hydrological condition. Therefore, the determination of hydrologic condition focuses on the analysis of the factors that most directly influence changes in flow, quality, or timing of water in a specific watershed of interest. Watershed characteristics that are not subject to change by management activities (e.g., geology, landform,

precipitation) are important in defining physical limits within which management actions can be expected to influence water F, Q, or T. Analysis and documentation of these watershed characteristics are fundamental to supporting interpretations of hydrologic condition and to define the limits of management influence over the physical system.

Because watersheds vary tremendously across the country, flexibility is needed to select the watershed characteristics which are most relevant for the watershed being considered. Therefore, the focus is on a process of analysis rather than a prescribed or fixed set of factors that drive the analysis. It permits the use of existing tools (e.g., regional curves, nomographs) and adaptation of the process based on available information, (local watershed case files), and local or regional conditions and needs. It is expected that standard procedures will be used to analyze factors indicative of hydrologic condition (e.g., techniques of Water Resources Investigations of the United States-Geological Survey, An Approach to Water Resources Evaluation of Non-Point Silvicultural Sources (A Procedural Document)-EPA). Use of existing information brings with it a wide range of reliability and confidence in the values. It is very important to document the level of confidence and the reliability of estimates and conclusions. It is important to document data voids which have decreased the reliability of conclusions.

The analysis steps follow a logical sequence that provide the basis for supporting professional estimates and judgments resulting in credible conclusions. The products of one step provide information for subsequent steps. The steps of the process are:

Step 1. Characterize Watershed- Organize, display, and document existing data and information about the watershed.

Step 2. Rate Factors- Rate relative importance of the factors used in Step 1 for potential to influence F, Q, and T.

Step 3. Identify Important Factors- Identify specific factors needed to determine hydrologic condition.

Step 4. Establish Current Levels- Quantify current ranges and status for the factors selected.

Step 5. Establish Reference Levels- Establish benchmark values for comparison by documenting the range of expected variation of the factors selected prior to any significant alteration of the watershed.

Step 6. Identify Changes and Interpret Results- Compare current and reference levels and provide interpretive conclusions.

The analytic process provides a starting point for discussion of hydrologic issues, related resource issues, and questions to be addressed through ecosystem and resource management planning. The analysis is intended to be watershed specific dealing only with factors associated with the specific watershed being analyzed. It is likely that the analytic factors will differ between watersheds, especially watersheds in substantially different geographic settings. However, within a common landscape unit, such as those defined by Bailey (1995), the important processes will likely be similar. This means that the knowledge gained in one analysis may be used to shape the next analysis.

DELINEATING WATERSHEDS

The BLM and Forest Service follow a standardized approach to Hydrologic Unit/Watershed delineation. The BLM/FS, working cooperatively with the NRCS, USGS, and other Federal and State parties, delineate hydrologic unit/watersheds (Seaber et. al. 1987) through the fifth code and as necessary, the sixth code at a scale of 1:24000. Protocols are based on surface watershed divides. The watershed boundaries are coordinated with adjacent states.

WATERSHED CASE FILES

To be effective and to provide credible advice and counsel to agency partners and interested publics in a timely manner regarding land management activities, agency staff need an understanding of fundamental hydrologic processes and basic/core hydro-meteorological facts for the land being analyzed. The published fundamental hydrologic concepts and basic hydro meteorological facts and their sources need to be identified, assessed, and managed on a watershed basis. From this information, specific factors that influence F,Q, and T are arrayed. Core hydro-meteorological data is assembled in order to (1) gain a basic understanding of the hydrologic cycle of a watershed, and (2) serve as a data source for assessing hydrologic changes due to land use management actions.

A permanent watershed case file is developed and maintained for each watershed. These case files build a picture of the basic characteristics of the watershed. By

incorporating studies, research reports and other documents that directly address activities in the watershed, historic conditions, response to severe storms, and other relevant information the current and future manager/analyst can quickly understand the watershed. Used properly, this case file improves efficiency by making key information readily available.

Watershed case files are numbered by the Hydrologic Unit Code and a watershed name. The case file will evolve from a empty numbered folder to a case file as each watershed analysis is performed. Developing full descriptive case files may take years or decades depending on the level of activity in a watershed and the priorities and resources that can be devoted to analysis.

APPLICATIONS

The Forest Service expects to apply these protocols for Hydrologic Condition Analysis to its Forest Land and Resource Management Planning process. The results will be used to help prepare Standards and Guidelines to protect or improve hydrologic conditions so that F,Q, and T are adequate for the beneficial uses of water flowing through National Forests.

In response to a request by the Environmental Protection Agency (EPA) Region 4, the Forest Service proposed a two phase approach. for analyzing hydrologic condition of watersheds and their treatment. Phase 1 is the analysis of hydrologic condition. The results from the hydrologic condition analysis are used to provide part of the rationale for listing or delisting waters that have impaired water quality per Section 303(d) of the Clean Water Act and to prioritize watersheds for treatment. Phase 2 is the preparation and implementation of a water quality recovery plan for those watersheds having impaired water quality. This plan is a project level plan and involves all the stakeholders in a watershed. It is used to: (1) identify specific source(s) and extent of pollution, (2) prescribe and schedule the implementation of treatments and their maintenance, (3) identify who is responsible for funding treatments and maintenance, and (4) include a monitoring and evaluation plan. Consideration is given to the potential for treatments and their maintenance based on economic, social, bio-physical resources, technological, and political limitations.

The Forest Service and EPA Region 4 have concluded that Phase 1, Hydrologic Condition Analysis, linked with Phase 2,Water Quality Recovery Plan, can provide a sound mechanism for dealing with nonpoint source pollution or problems.

ACKNOWLEDGMENTS

The work by the BLM/FS core team is appreciated in the preparation of this paper.

LITERATURE CITED

Bailey, Robert G. 1995. Description of the Ecoregions of theUnited States. USDA Forest Service. Miscellaneous Publication 1391.

Seaber, Paul R., F.Paul Kapinos, and George L. Knapp. 1987. Hydrologic Unit Maps. United States Geological Survey Water Supply Paper 2294.